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Standard Practice for Manufacturing Characterization of Computed Radiography Systems[1]

This standard is issued under the fixed designation E2446; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the manufacturing characterization of computed radiography (CR) systems, consisting of a particular phosphor imaging plate (IP), scanner, software, scanner operational parameters, and an image display monitor, in combination with specified metal screens for industrial radiography.

1.2 The practice defines system tests to be used to characterize the systems of different suppliers and make them comparable for users.

1.3 This practice is intended for use by manufacturers of CR systems or certification agencies to provide quantitative results of CR system characteristics for nondestructive testing (NDT) user or purchaser consumption. Some of these tests require specialized test phantoms to ensure consistency of results among suppliers or manufacturers. These tests are not intended for users to complete, nor are they intended for long term stability tracking and lifetime measurements. However, they may be used for this purpose, if so desired. Practice E2445 describes tests which are intended for users to observe the CR performance and test the long term stability.

1.4 The CR system performance is described by the basic spatial resolution, contrast, signal and noise parameters, and the equivalent penetrameter sensitivity (EPS). Some of these parameters are used to compare with DDA characterization and film characterization data (see Practice E2597 and Test Method E1815).

NOTE 1—For film system characterization, the signal is represented by the optical density of 2 (above fog and base) and the noise as granularity. The signal-to-noise ratio is normalized by the aperture (similar to the basic spatial resolution) of the system and is part of characterization. This normalization is given by the scanning circular aperture of 100 μm of the micro-photometer, which is defined in Test Method E1815 for film system characterization.

1.5 The measurement of CR systems in this practice is restricted to a selected radiation quality to simplify the procedure. The properties of CR systems will change with radiation energy but not the ranking of CR system performance. Users of this practice may carry out the tests at different or additional radiation qualities (X-ray or gamma ray) if required.

1.6 The values stated in SI are to be regarded as the standard.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E746 Practice for Determining Relative Image Quality Response of Industrial Radiographic Imaging Systems

E1165 Test Method for Measurement of Focal Spots of Industrial X-Ray Tubes by Pinhole Imaging

E1316 Terminology for Nondestructive Examinations

E1815 Test Method for Classification of Film Systems for Industrial Radiography

E2002 Practice for Determining Image Unsharpness and Basic Spatial Resolution in Radiography and Radioscopy

E2007 Guide for Computed Radiography

E2033 Practice for Radiographic Examination Using Computed Radiography (Photostimulable Luminescence Method)

E2445 Practice for Performance Evaluation and Long-Term Stability of Computed Radiography Systems

[1] This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.01 on Radiology (X and Gamma) Method.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

E2597 Practice for Manufacturing Characterization of Digital Detector Arrays

E2903 Test Method for Measurement of the Effective Focal Spot Size of Mini and Micro Focus X-ray Tubes

2.2 *ISO Standard:*[3]

ISO 17636-2 Non-Destructive Testing of Welds—Radiographic Testing—Part 2: X- and Gamma Ray Technologies with Digital Detectors

3. Terminology

3.1 *Definitions*—The definition of terms relating to gamma- and X-radiography, which appear in Terminology E1316, Guide E2007, and Practice E2033, shall apply to the terms used in this practice.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *computed radiography system (CR system)*—a complete system of a storage phosphor imaging plate (IP), a corresponding read out unit (scanner or reader), software, scanner operational parameters, and an image display monitor, which converts the information of the IP into a digital image (see also Guide E2007).

3.2.2 *computed radiography system performance level*—a particular group of CR performance levels, which is characterized by an SNR_N (normalized signal-to-noise ratio) range, an interpolated basic spatial resolution range $iSR_b^{detector}$ and equivalent penetrameter sensitivity (EPS) shown in Table 4 in a specified exposure range.

3.2.3 *gain/amplification*—opto-electrical gain setting of the scanning system.

3.2.4 *ISO speed* S_{IPx}—defines the speed of a CR system and is calculated from the reciprocal dose value, measured in Gray (Gy), which is necessary to obtain a specified minimum SNR_N of a CR system performance level.

3.2.5 *linearized signal intensity*—a numerical signal value of a picture element (pixel) of the digital image, which is proportional to the radiation dose. The linearized signal intensity is zero, if the radiation dose is zero.

4. Significance and Use

4.1 There are several factors affecting the quality of a CR image including the basic spatial resolution of the IP system, geometrical unsharpness, scatter and contrast sensitivity. There are several additional factors (for example, software and scanning parameters) that affect the accurate reading of images on exposed IPs using an optical scanner.

4.2 This practice is to be used to establish a characterization of CR system by performance levels on the basis of a normalized SNR, interpolated basic spatial detector resolution and EPS. The CR system performance levels in this practice do not refer to any particular manufacturers' imaging plates. A CR system performance level results from the use of a particular imaging plate together with the exposure conditions, standardized phantom, the scanner type, and software and the scanning parameters. This characterization system provides a means to compare differing CR technologies, as is common practice with film systems, which guides the user to the appropriate configuration, IP, and technique for the application at hand. The performance level selected may not match the imaging performance of a corresponding film class because of the difference in the spatial resolution and scatter sensitivity. Therefore, the user should always use IQIs for proof of contrast sensitivity and basic spatial resolution.

4.3 The measured performance parameters are presented in a characterization chart. This enables users to select specific CR systems by the different characterization data to find the best system for his specific application.

4.4 The quality factors can be determined most accurately by the tests described in this practice. Some of the system tests require special tools, which may not be available in user laboratories. Simpler tests are described for quality assurance and long term stability tests in Practice E2445.

4.5 Manufacturers of industrial CR systems or certification agencies will use this practice. Users of industrial CR systems may use Practice E2445 or perform some of the described tests and measurements outlined in this practice, provided that the required test equipment is used and the methodology is strictly followed. Any alternative methods or radiation qualities may be applied if equivalence to the methods of this practice is proven to the appropriate cognizant engineering organization.

4.6 The publication of CR system performance levels will enable specifying bodies and contracting parties to agree to particular system performance level, as a first step in arriving at the appropriate settings of a system, or the selection of a system. Confirmation of necessary image quality shall be achieved by using Practice E2033.

5. Apparatus

5.1 CR system evaluation depends on the combined properties of the phosphor imaging plate (IP) type, the scanner and software used, and the selected scan parameters and image display monitor. Therefore, documentation for each test shall include the IP type, scanner, software, scan parameters, and image display monitor, and the results shall be calculated and tabulated before arriving at a performance assignment. The applied test equipment for SNR measurement (Fig. 1) and algorithm 6.1.1 correspond to Test Method E1815. The recommended thickness for aperture test object (diaphragm) is 10.2 mm (0.4 in.) of Pb. The SDD shall be at least 1 m (39 in.). Do not use any material (for example, lead) behind the cassette and leave a free space of at least 1 m (39 in.) behind the cassette or use a steel screen of about 0.5 mm (0.02 in.) and a lead plate of >2 mm (0.08 in.) just behind the cassette (steel screen is positioned between cassette and lead) and in contact with the cassette.

5.2 The step wedge method (Fig. 2) describes a simpler procedure for SNR measurement than described in Test Method E1815, which permits obtaining similar results with less expense, and less accuracy.

[3] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, http://www.iso.org.